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Effect of Group Work in Addressing the Misconceptions of Light

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Authors' contributions

This work was carried out in collaboration between both authors. The study is done by the author individually as a part of the master course under the guidance of supervisor author TP. Both authors read and approved the final manuscript.

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ABSTRACT

Physics is science that determines the living and life styles of the people. However, it has many misconceptions in the concepts. In this study, the effect of group work and traditional method in addressing the Class IX student's misconceptions about light is investigated. The explanatory sequential mixed method was used for the study. It was carried out in one of the Middle Secondary School [MSS] under Trashigang district. The sample of this study consisted of 42 Class IX students and 5 science teachers. The data collection was done using multiple choice questions as pre-test and post-test with explanations. The semi-structured interview was conducted to support the quantitative findings.

The data obtained indicated that the students in the experimental group were more successful in addressing the misconception of light concept than the control group. The independent t-test result showed the significant difference in terms of mean score $p<0.05$ in the post test result. The result obtained from the study rejects the null hypothesis. The findings confirm that the group work is effective in addressing the misconceptions of light comparing to traditional method of teaching and learning.

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Keywords: Misconceptions; alternate conceptions; cooperative learning; group work; light rays; refraction of light.

1. INTRODUCTION

1.1 Problem Statement

Physics is one dynamic discipline of science that is always developing and thriving rapidly. The concepts and principles of Physics are used in different activities such as in the transportation, communication, power generation, space science and operating different machines. Physics has also contributed so much towards the development and functioning of our lives especially in this modern period of science and technology.

Over the decades, Physics has been perceived as a tough subject in comparing to Biology and Chemistry as it requires more analytical skills [1]. According to Pupil's Performance Report 2014 of Bhutan, it reveals that the overall mean score of physics was low comparing to biology and chemistry. The overall mean score for physics was 52.6 whereas the mean score of biology and chemistry was 57.7 and 57.9. It is may be due to the high conceptual nature of the discipline, with many interlinked ideas and abstract concepts. It can be due to misconceptions in learning physics because misconception has a probability to make mistakes in learning [2].

It is important to observe that misconceptions in subject can also lead to conceptual mistakes and might be a hindrance for learning scientifically correct concepts. Misconceptions should not be considered as a loopholes for students to incorporate new knowledge, rather it acts as a necessary starting point from which student will be able to build new scientific understanding from a constructivist point of view [3].

All the stakeholders want the education to improve timely so that beneficiaries firmly withstand the demands of existing society. When education is faced with persistent challenges and universal levels of under-achievement of students, sustainable alternatives such as ability grouping are gaining the ground widely [4]. According to Mutch [5], group work in education helps to reflect the patterns and possible expectations that learners would encountered in working life. That is, the use of group work tasks has aimed to develop the skills necessary to prepare students for their future life. The students gain skills such as socialization skills, communication skills, listening skills and become more responsible in carrying out any activities.

The topic Light particularly refraction and dispersion of light are found in secondary science curriculum. Shallcross [6] found that there exist conceptual difficulties for learners in understanding the topic light. According to her, common misconceptions in light are reflective surface emits light, only shiny surfaces or water reflect light, opaque object do not reflect light and opaque surfaces gives out darkness. Previous literatures [7,8,9,10] have shown that students hold a variety of alternate conceptions about the light. Some prominent misconceptions of light are, light always passes straight through transparent materials, light is not necessary to see since we can see little in the dark room, shadow is the reflection of an object, light travels further at night than during the day and each point on luminous object emits light in one direction.

Many studies [11,3,12,13] have been done to address the misconception of Physics on quite a number of topics to enhance the learning outcomes. However, in all the studies, the involvement of explicit group work in addressing the misconception of the light topic is not reflected. This study is intended to find effectiveness of group work activity in addressing misconception of light in comparing to traditional lecture method.

1.2 Purpose

The study aims to:

- Investigate the effect of group work in addressing the misconception of light.
- Explore the effect of group work over the traditional method of teaching and learning.

There are six research objectives that would facilitate the achievement of the mentioned aims. The objectives are:

- identifying the misconceptions in the light and finding out the sources of its cause.
- finding out the types of group work used in the classrooms.
- investigating the impact of group works in learning physics.
- finding out the current trends of teachers addressing the misconceptions.

- collecting the perceptions of teachers and students towards group work.
- analysing the effect of group work in addressing the misconception of light concept.

1.3 Research Questions

1.3.1 Central question

What is the impact of group work in addressing the misconceptions of light in Class IX physics?

1.3.2 Sub questions

1. What are the prevailing misconceptions in light?
2. What are some of the sources of misconceptions in light?
3. How misconceptions are addressed normally by teachers in the school?
4. What are the perceptions of using group work by teachers and students in learning physics?
5. What types of group work are being practiced in the school?
6. How does group work affect in addressing misconceptions of light?

The study began with null hypothesis and an alternative hypothesis that states,

H_0: The group work will not have any impact in addressing misconceptions of light.
H_1: The group work will have positive impact in addressing misconceptions of light.

1.4 Significance, Scope, and Definitions

The findings of the study convey the strong message that as simple as group work can also address misconception of the light concepts in physics. The study reassures the ministry's stress on the implementation of cooperative learning that it benefits the learners academically and non-academically. Academically, learners improve their performances and it helps to develop many societal skills non-academically. It prompts the teachers to use group works in teaching because it is one of the active learning strategy that is more feasible in our context. For the future researchers, this study would provide baseline information in Bhutanese context of its kind. In the process of the study, it would benefit students in overcoming the misconceptions and also benefits teachers in addressing misconceptions of the particular topic.

2. LITERATURE REVIEW

2.1 Physics: Its Importance, Its Nature and Probable Hindrances in Learning

Ever since the evolution of science, it tries to strive in making a living the most comfortable and meaningful on the earth. It seeks an understanding of natural phenomena by means of establishing fundamental knowledge [14]. Physics is a science of mechanics, energies, motions and technologies that directly determines the living standard and style of the people. It makes pupils to learn the tools and methods for a deeper understanding of natural phenomena and natural laws [15]. At the same time, it gives them the necessary basis for a better understanding and use of modern technology and helps them better orient themselves in everyday life. The physics knowledge also help the students to learn to ask question and to seek answers to them, to explain the observed phenomena, to solve cognitive or practical problems, and to use their knowledge of the laws of natural processes in order to predict for the future [16].

Physics at any level is not so easy as it requires problem solving techniques and critical thinking skills [17]. The learning of physics is hindered by many factors, such as inadequate learning in the previous class, weak mathematics background, teaching by general teacher, poor pedagogical content knowledge of teacher, and lack of motivation and confident in learning physics and misconceptions developed within the learners [18]. If the above stated hindrances are not addressed and is ignored, leaners who are neither interested and nor motivated to learn the subject will increase and it will contribute to develop negative attitude and perceptions to the subject. If the students have misconceptions, these will impede their learning and it will become difficult to connect to new knowledge with their existing knowledge. Because of this condition, students may not achieve conceptual understanding in a learning process [14].

2.2 Misconceptions, Categories of Misconceptions and the Ways of Addressing It

Misconceptions in educational studies are widely started during 1980s and they are still continuing [19]. Misconception is mismatching of the sci-entific definition of concept and the definition formed in students' minds and it conflicts with the

expert opinions in related areas [20,21,14]. Unless the study is truly based on scientific research, the fact of prevailing misconception in any field of study cannot be denied. In fact, even the scientific based study too carries misconceptions as there stands errors in it. The negative attitudes of students towards the subject have been suggested as a contributory factor to misconceptions [22]. He further explained that inadequacies of furniture fitting and equipment in the classrooms and laboratories where teaching and learning of science subjects took place might also contribute to misconceptions. According to Demirci [23], misconceptions are grouped into five categories such as preconceived notions, non-scientific beliefs, conceptual understanding, vernacular misconceptions and factual misconceptions. He defined misconceptions as:

i) Preconceived notions are information that is already encrypted before somebody teaches the concept.
ii) Non- scientific are those learning from religious perspective.
iii) Vernacular are misconception with regard to usage of words.
iv) Conceptual misunderstanding arises when one cannot connect to new information.
v) Factual misconceptions are falsities learned at the early age and retained unchallenged into adulthood.

Misconception can be addressed through various strategies. Generally, misconceptions are addressed through conceptual change model and constructivist learning model [24]. The conceptual change is learning gateways from learner's preconceptions to the science concepts through experiment and modeling [25]. Within the cognitive developmental psychology, the interest in conceptual change was motivated by problems identified in the stage theory of cognitive development proposed by Jean Piaget. The developing child passed through a series of four distinct stages of thought and that concept development reflected these broad transitions between stages [26]. However, it increasingly became apparent that children's conceptual development was best described in terms of distinct developmental trajectories for each conceptual domain considered. According to Stepans [27], the processes of conceptual change model are committing to a position, exposing belief, confronting belief, accommodating the concept and extending the concept. Constructivism emphasizes on the importance of the knowledge, beliefs and skills that an individual brings to the experience of learning [28]. In all the strategies that are used to reduce misconceptions in science subject, group work is implicitly used as it is one of the active learning strategies and learner-centered strategy.

2.3 Light and Misconceptions of Lights

Light is a main constituent of many modern technologies and is used as the primary tool in many sciences ranging from Astronomy to Zoology [29]. The field of optics is a complex area for the learners and many studies has shown students' difficulties in learning optics [30,9,10,31,6,32]. There are many misconceptions associated to Light concepts. According to Blizak [29] students think that light travels further at night than during day time, shadow is same as an image, shadow is a reflection of an image, strong source of light gives bigger shadow, light always travel in a straight path, light reflects only from the smooth surface, object are black because they do not reflect light, an object is seen because light shines on it, mirror reflects all light that shines on their surfaces, light travels infinitely fast, all radiations are harmful and prism produce different colors of light. There are misleading explanations of the light phenomena in textbooks and website regarding the directions of light rays [8].

The misconceptions in lights are because of the abstract theoretical concepts under the topic optics. Light is a complex and difficult concept that lends itself to misconceptions among the teachers and the students [33]. It is also due to students' learning experiences in the previous years, use of textbooks with errors or lack of clear conceptual information in the textbooks and language or connotations used by teachers while teaching the lesson [34]. When students don't have enough ability and knowledge to seek information from the internet, they end up obtaining irrelevant information whereby students' misconceptions are added [35].

Misconceptions cannot be neglected on the note of limited time, lack of expertise, vast syllabus ahead, societal obeisance, and peer pressure. Although misconceptions do contribute to the understanding of the subject to certain extend, stressing to pursue with that is not acceptable at large as it is scientifically contradictory. Also the stronger are the misconceptions, the more

resistant to change it becomes and create a conceptual barrier that minimize or prevent the learning [7]. Misconceptions are addressed through various means; using conceptual change model, constructivist theories, laboratory experimentation, information technologies based teaching, and through researched based projects.

2.4 Pedagogical Shift

Today, the mostly talked discussion in the education field is the changing of teaching style from traditional to twenty-first-century pedagogy. The misconceptions that students have concerning physics before taking a class in physics seem to persist with traditional instruction of teaching [36]. The use of traditional teaching method based instruction is found to be ineffective for learners to gain a concrete understanding of physics concept [37]. An active learning such as the use of small group in problem-solving tasks in classrooms, produces better learning outcomes [38]. Burke [39] argue that the student-centered learning and active learning is the focal point of all the education system around the globe. Cooperative learning and group work activity are prioritized over other methodology as an active learning theory because it helps to learn by participating equally and actively [40].

2.5 Group Work Method in Teaching and Learning

Group work falls under the constructivism model of learning [41]. The group work plays an essential role in students' thought processing and in criticizing constructively, ultimately leading to productive and beneficial outcomes in student learning. Group work based on [42] are categorized into two groups. They are behavior and cognitive group work. The behavior group focused on whole behavior, learning style and how the learner behaved and interact during instruction hours. In the cognitive group, student's academic intellectual is considered.

According to Slavin [43], group work can be also categorized into two as homogeneous group and heterogeneous group. In heterogeneous groups, students in a group differ on the basis of gender, race, learning ability, and previous academic performance. In homogeneous groups, students in a group have similar learning abilities, previous academic performance, and other cognitive characteristics. The focused is on the effects on academic achievement and satisfaction of students when they are either in heterogeneous or homogeneous group [44] s. Researchers express different views about the effects of heterogeneous and homogeneous ability-grouping on student learning.

Most of the educationist prefer the cognitive group work type of grouping as it brings equity in acquiring skills and cognitive intelligence. It is most often termed as ability grouping because student's academic performing ability is kept as the basis or center point. In our context, the mixed ability grouping or heterogeneous grouping is widely practiced. It refers to grouping students of different abilities [45]. The mixed-ability group work focused first on organizational and social structures, then participatory practices, and finally to students and their own sense-making [4]. It helps to increase interaction across students with different abilities. Further it benefits the learners by sharing their intellectual and social interaction among themselves during learning. It also improves analytical skills, critical thinking skills, problem solving and communication skills [41].

Adoption of Kagan Structure and cooperative learning by the ministry of education in 2016 has immense impact in learning all the subjects. Students in small groups taking turns in contributing the points is the major focus [46]. It also worked well to equalize participation in cooperative learning teams. Therefore, in simple, Kagan structure is group work with time-honored way of structuring interaction.

Group work generally aims to develop intellectual understanding, abilities and skills, communication, cooperative and teamwork skills, personal and professional growth and encourage being more independent and taking ownership of their own learnin [47] g. It also enables students to discuss issues or to engage in joint activities with other students in a less threatening environment [40].

According to Goris & Dyrenfurth [48], instead of using a single method, keeping students' differences in mind, it will be more effective to use various methods to remove misconceptions. In this study, different ways of studying physics particularly light were carried out by forming groups. As far as group work is concerned, several different methods can be found in the literature. For the study, ability grouping is followed as per the existing format in the schools of the country.

The number of studies conducted on the effect of group work on students' misconceptions is quite small [49,18,50,51]. So far, no research has been carried out in Bhutan on addressing misconception in light through group work. Therefore, this study "Effect of Group Work in Addressing Misconceptions of Light" was investigated to explore the effect of group work over individual learning in addressing the misconception of light.

3. METHODOLOGY

3.1 Research Design

The philosophical assumption is based on the scientific method. The study involves series of steps. The study began with the problem statement, null hypothesis, intervention and finally relates the outcomes with the proposed hypothesis. Since the study has multiple purpose and used two ways approach for the outcome, the paradigm mostly focussed is pragmatism. The study finds out the impacts of group work in teaching and learning, it compares the group work teaching with traditional teaching method, it works to address the misconception, and compare two methods of teaching in addressing the misconceptions of light. The critical theory is the interpretive framework in the study because the selection of groups and group members in each control and experimental group do not differentiate among the race, gender, and societal status. The research design is explanatory sequential mixed method where quantitative is followed by qualitative method.

3.2 Methods

In this study, mixed method is used. As a quantitative, quasi-experiments is used. In quasi-experiments, the researcher uses both control and experimental group, but does not randomly assign participants to the groups. Quasi-experiment is an empirical intervention study to estimate the causal impact of an intervention on its target sample. As a qualitative method, there was semi-structured interview with five students and five teachers. An interview was an additional data information for further validation of the study.

3.3 Participants

The sample of the study consisted of students attending two sections of Class IX in one of MSS in Trashigang. The students were in the second term of the 2018 academic session. One section was selected as the experimental group and the other as the control group. The student's ages ranges from 15-18. The numbers of students belonging to the experimental group and the control group were shown below.

Table 1. Student numbers of experimental and control group

Class	Girls	Boys	Total
9-A (Experimental)	14	7	21
9-B (Control)	14	7	21
Total	28	14	42

3.4 Instruments

By taking into consideration the chapter of 'Light' within the context of the study, Test Questions (TQ) was designed as a multiple choice test with four options to evaluate the target student's scores from the Class IX physics textbook. The question specifications were prepared according to textbook and it was examined and corrected by a supervisor who is leading experts on the subject. After the necessary corrections were made, the TQ was administered with 55 students studying in Class X as a pilot test and the reliability of the test was determined. The diagrams were included in the questions and the reliability coefficient (with Cronbach alpha) was determined to be *0.724*. The TQ was applied to all groups as both pre-test & post-test to determine the change in the academic achievement level.

The other reason for the pilot test was to identify the misconceptions under the topic light. Based on their performance in the test and the supporting reason they expressed while answering, nine misconceptions were identified. There were 9 misconceptions identified and they are as follows:

i. Speed and angle of incident do not affect the bending of light.
ii. Ray of light is not always refracted in definite direction.
iii. The refracted ray does not bend away from the normal as it travels from denser to rarer medium.
iv. Lateral displacement does not depend on thickness of the medium, angle of refraction and angle of incidence.
v. The colour of the light, material of the medium and temperature do not affect refractive index.

vi. If the angle of the incidence of the light while leaving the denser medium is zero, the light refracts.
vii. If the angle of incidence is greater than the critical angle, the total internal reflection of the light is not possible.
viii. Twinkling of star is due to total internal reflection of light.
ix. Total internal reflection won't occur if the angle of refraction is $99°$ (greater than critical angle).

The pre-test was conducted for both the control group and experimental group. The test consisted of 20 questions with four possible answers and at the same time participants were asked to write their reasons wherever is necessary. The pre-test scores were used to find out whether the two groups had any significant difference or not as the study used purposive sampling. It was found that there was no significant difference in the performance of the pre-test.

After the pre-test, there was an intervention for both the groups but the method was different. For the control group, method was centered on individual learning and for experimental group, much stressed was towards the group learning. Then there was a post-test for both the groups and the questions were same for comparison. There was a semi-structured interview with 5 teachers and 5 students.

3.5 Procedure: Teaching the Lesson (Intervention)

In the study, the teaching was carried out in the experimental group and the control group by the writer of the paper during the 2018 academic session and there was an informal and unstructured classroom observation while teaching the class.

For the control group, teaching of light particularly refraction and dispersion of light was based on the traditional method where lecture and demonstration were mostly stressed. The control group did not participate in any team studies or activities since such an activity was not an essential part of the traditional method. During the lectures, students were asked questions and feedbacks were made according to their answers. Students were also given homework for studying the subjects out of the class. At the end of each lesson, the students were asked to read about the subjects of the next lesson and be prepared for it. In the control group, lecturing of the subjects included in the 'Light' chapter lasted for one week. Then there was post-test at the end of the lesson.

In the experimental group, group work activity was stressed in teaching the lesson. Teaching and learning through group work aims to enable students to work in peer as well as in team using different activities and structured time for each activity. The detailed instructions were given to students before the start of teaching the group work method. The formation of group was done based on the academic performance and gender.

The maximum attention was paid to develop the social atmosphere rather than isolated atmosphere in teaching the experimental group. Students were encouraged to work in groups and express their ideas freely to group members. The minor debates were included as a part of activity to make them aware of their own ideas and friend's ideas, make critics about their answers and also to reorganize or change the ideas if it is needed. The teaching lasted for one and half week and at the end students attended the post-test.

3.6 Analysis

The data gathered in this study were collected applying the data collection tool (Instrument) as pre-test and post-test and semi structured interview. The data collected using tests had been analyzed using SPSS version 22.00 and presented in graphs and tables, statements and interpreted quantitatively. The data that had been gathered through interview were transcribed, arranged thematically, interpreted qualitatively (content analysis) and presented in a summarized form.

In conducting this study, researcher had followed all the principles of research ethics.

4. RESULTS

4.1 Quantitative Data Analysis

In this part, student's misconception on light addressed through group work is analyzed according to data from pretest and post-test. The study examined the effect of group work by dividing the participants into two groups; experimental group and control group.

4.2 Misconceptions of light

The misconceptions were identified from the data collected from the pilot test. After that, there was

pre-test, intervention and post-test. The figures show whether identified misconceptions are addressed or not after the intervention with different methods (group work and traditional method). For convenience, the data is represented in percentage.

4.2.1 Misconception 1: Speed and angle of the incidence do not affect the bending of light

As shown in Fig. 1, the percentages of the experimental and the control group students having the misconception in the pre-tests are equal (75%). After the intervention, the percentage of the experimental group students having the misconception for the pre-tests decreases to 5% and the control group students decreases to 55%.

4.2.2 Misconception 2. Ray of light is not always refracted in a definite direction

According to Fig. 2, the percentage of having this misconception is higher for the experimental group (90%) than in the control group (70%) in the pre-tests. In the post-tests, the percentage of the experimental group is 10% while that of the control group is still 70%. That tells that there is no effect even after the intervention for the control group.

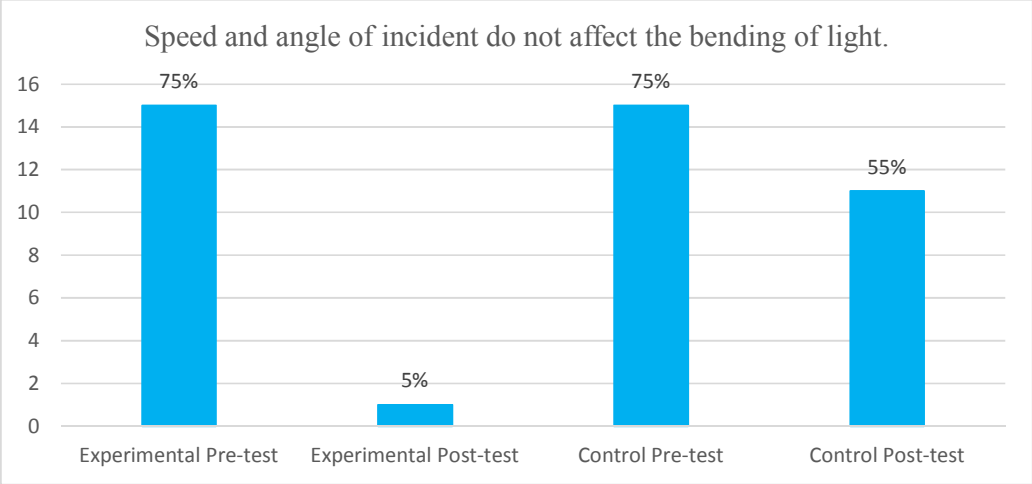

Fig. 1. The percentage of students who have the misconception on "Speed and angle of the incident do not affect the bending of light"

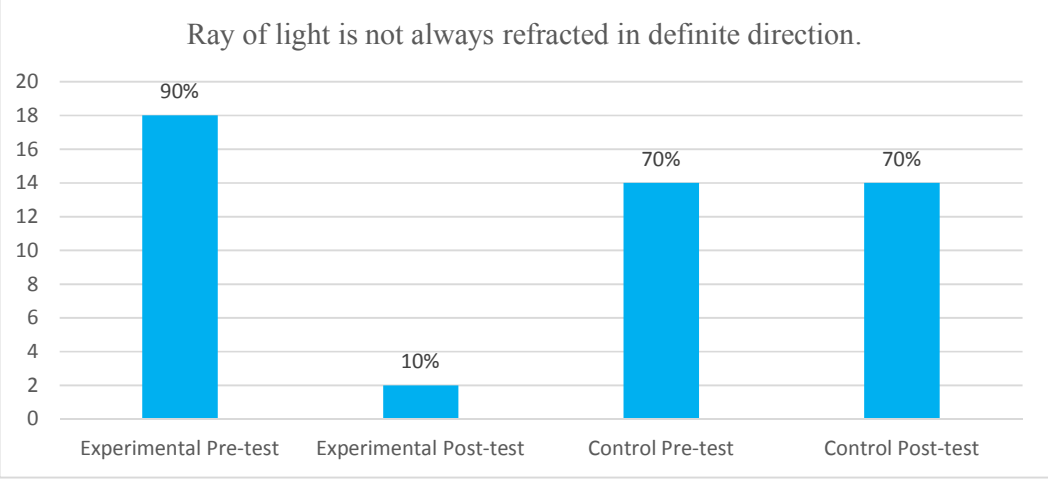

Fig. 2. The percentage of students who have the misconception "Ray of light is not always refracted in a definite direction"

4.2.3 Misconception 3. The refracted ray does not bend away from the normal as it travels from denser to rarer medium

According to Fig. 3, the percentage of having this misconception in the pre-test is 55% for experimental group and 39% for the control group. In the post-tests, the percentage of the experimental group is reduced to 5% and the control group to 10%.

4.2.4 Misconception 4. Lateral displacement does not depend on the thickness of the medium, angle of refraction and angle of incidence

When Fig. 4 is analyzed, misconceptions were removed in both the groups after the intervention. According to the pre-test, the percentage of having the misconception among experimental group students is 95% and 90% for the control group. In the post-tests, the percentage of having this misconception is 40% in the experimental group and 75% in the control group.

4.2.5 Misconception 5. The colour of the light, the material of the medium and temperature do not affect refractive index

According to Fig. 5, the percentage of students with this misconception in the pre-tests for the experimental group is 95% and 100% for the control group. The percentage of students with this misconception is very high for both groups. In the post-tests, the number of students having the misconception decreases to 30% in the experimental group and 55% in the control group.

4.2.6 Misconception 6. If the angle of the incidence of the light while leaving the denser medium is zero, the light refracts

According to Fig. 6, for the pretests, 75% have this misconception compared with 60% for the control group. The percentage for the experimental group is higher than the control group. According to the post-tests result, there was a drastic reduction for the experimental group. This misconception has decreased to 15% while there is a reduction by only 5% for the control group.

4.2.7 Misconception 7. If the angle of incidence is greater than the critical angle, the total internal reflection of the light is not possible

In Fig. 7, the percentage of having this misconception for the pre-tests is 85% for the experimental group, and 55% for the control group. The percentage of the experimental group students having this misconception is higher than the percentage of the control group students. According to the post-tests, the rate of the experimental group students having this misconception falls to 15%. However, the same rate rises to 70% for the control group. It is remarkable that the rate for this misconception has increased for the control group while it decreases in the experimental group by almost 4 folds.

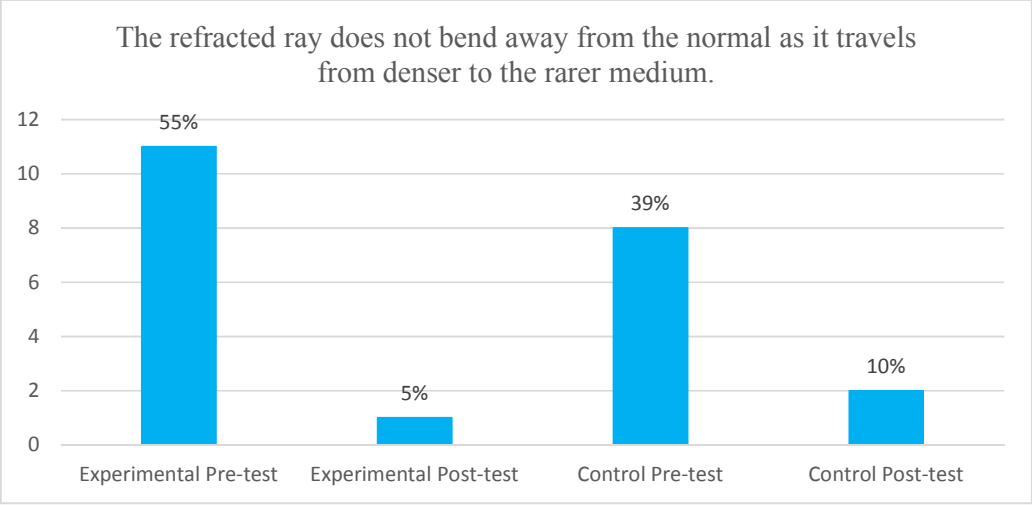

Fig. 3. The percentage of students who have the misconception "The refracted ray does not bend away from the normal as it travels from the denser to the rarer medium"

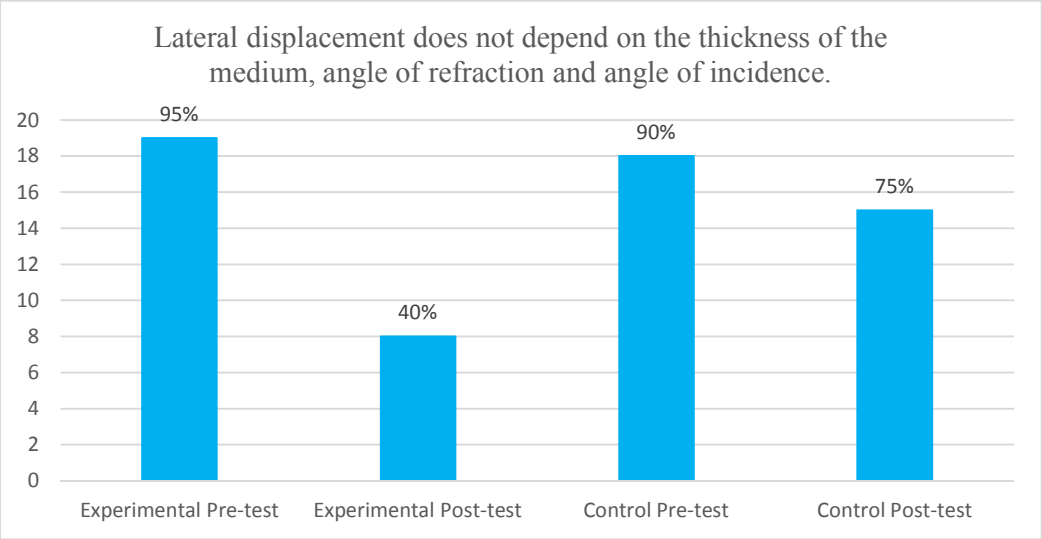

Fig. 4. The percentage of students with the misconception "Lateral displacement does not depend on the thickness of the medium, angle of refraction and angle of incidence"

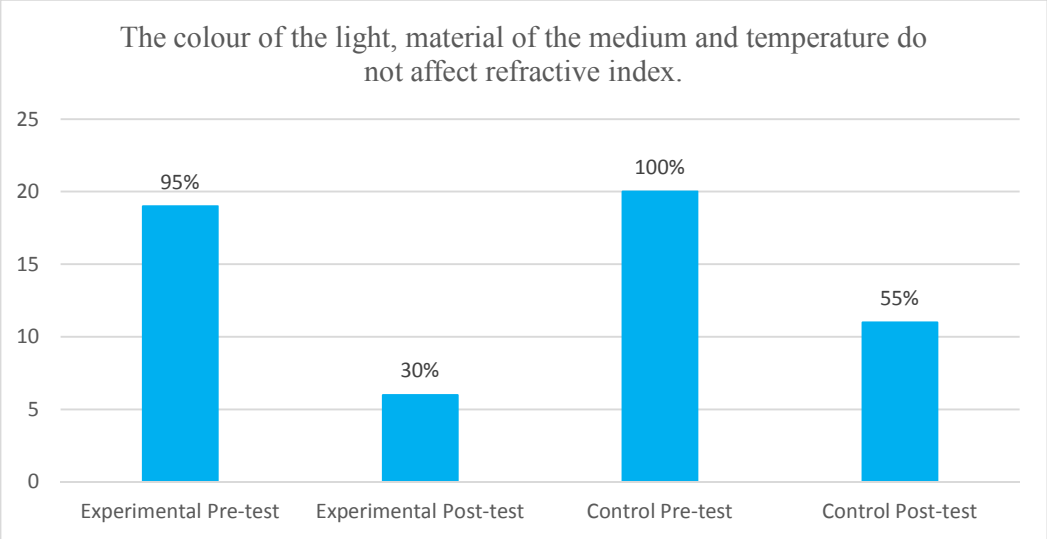

Fig. 5. The percentage of students who have the misconception "The colour of the light, material of the medium and temperature do not affect refractive index"

4.2.8 Misconception 8. The twinkling of the star is due to total internal reflection of light

When Fig. 8 is analyzed, a misconception in an experimental group reduces while misconception in control group increases after the interventions. According to the pretest, the percentage of having the misconception among experimental group students is 75% and 70% for the control group. In post-tests, the percentage of the student having this misconception in the experimental group is 35% and 80% in the control group.

4.2.9 Misconception 9. Total internal reflection won't occur if the angle of refraction in the rarer medium is 99°

In Fig. 9, all the students have the misconception about the internal reflection and its critical angle. According to the post-tests, for the experimental group misconception falls to 40%. However, there is a slight drop for the control group (85%).

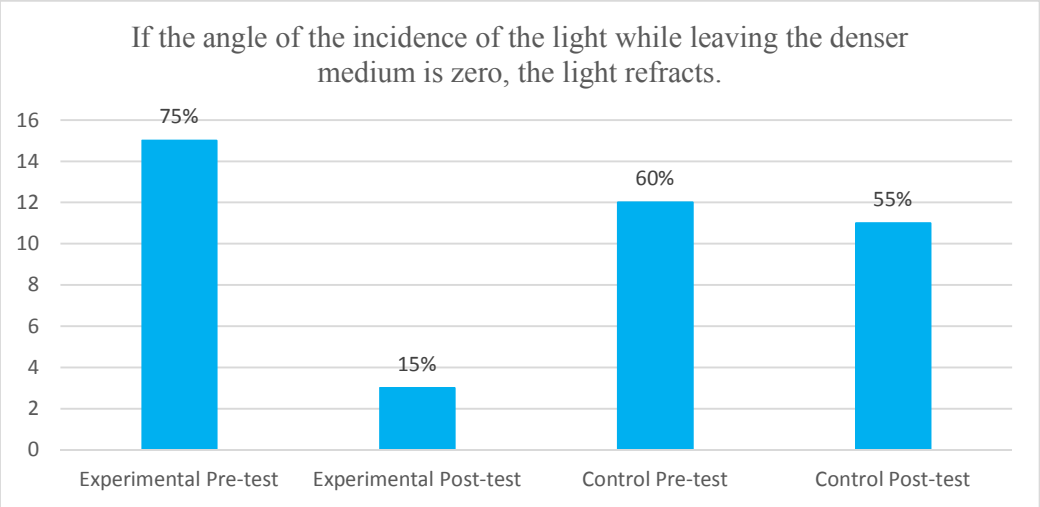

Fig. 6. The percentage of students who have the misconception "If the angle of the incidence of the light while leaving the denser medium is zero, the light refracts"

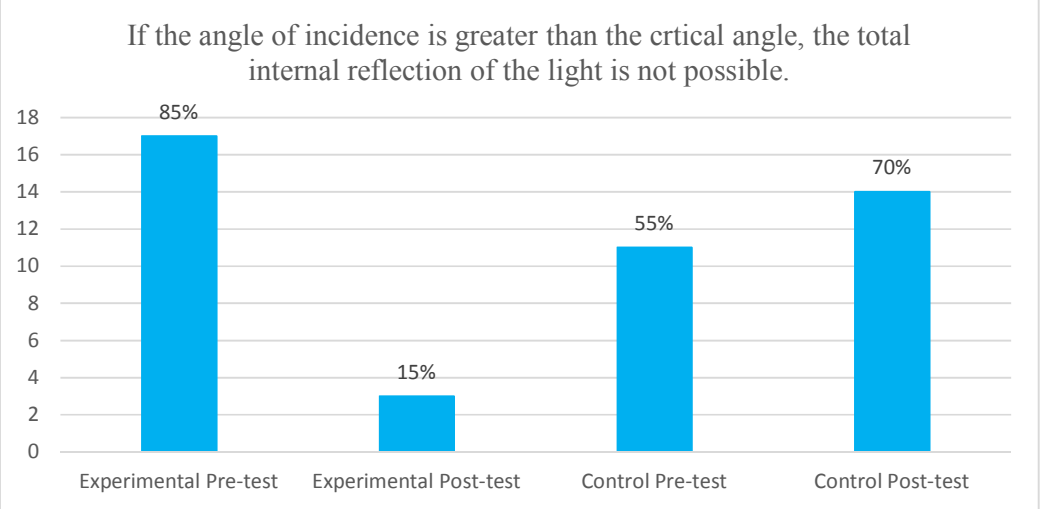

Fig. 7. The percentage of students who have the misconception "If the angle of incidence is greater than the critical angle, the total internal reflection of the light is not possible"

4.3 Pre-test and post-test comparisons using T-tests

An identical pretest and post-tests were administered to both experimental and control group, before and after the interventions. The test covered five subtopics of light in IX physics containing 20 questions. Each multiple-choice questions have an alternative to write a reason for the choice. The results of the test were analyzed in the SPSS software. The results were compared in three different ways; within the control groups, within the experimental groups and between the control and experimental group using t-test from the SPSS.

The table below shows the comparison of the results for control group.

Table 2. Paired sample test for control group

	Mean	N	Std. Dev.	t	p
pretest	5.71	21	1.41	-7.246	.000
posttest	8.71	21	1.64		

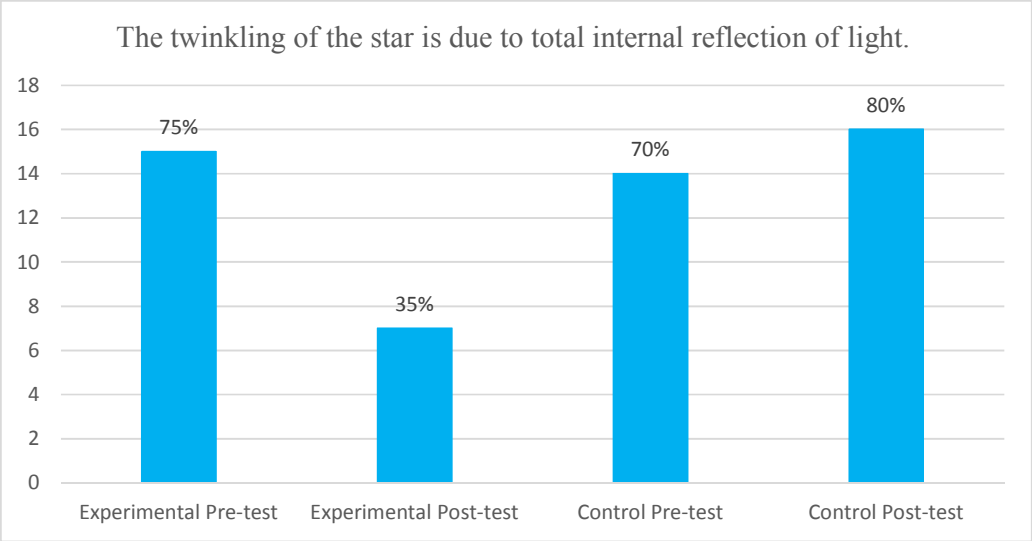

Fig. 8. The percentage of students who have the misconception "The twinkling of the star is due to total internal reflection of light"

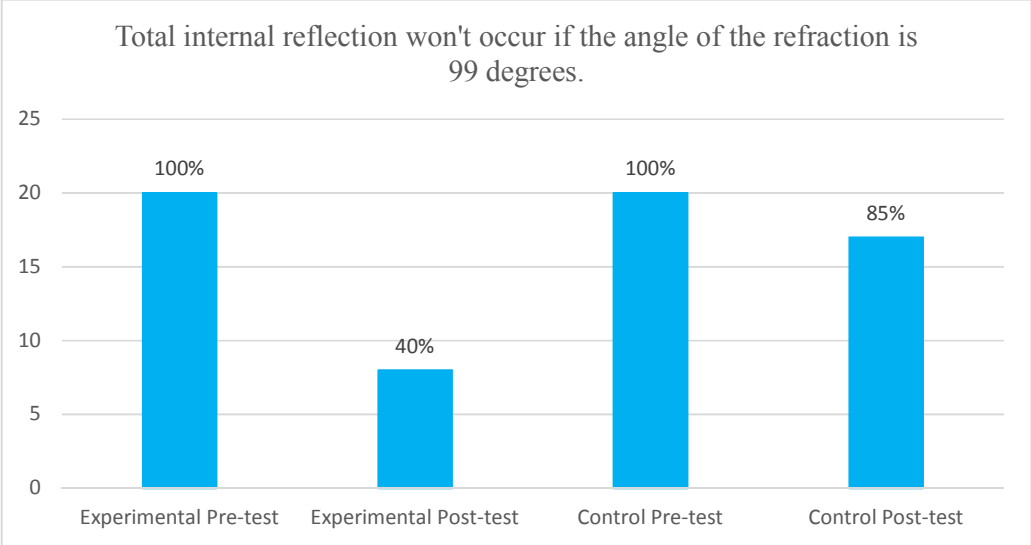

Fig. 9. The percentage of students who have the misconception "Total internal reflection won't occur if the angle of refraction is 99° (greater than the critical angle)"

The correlation between the control group pretest and post-test scores for misconceptions was analyzed using the paired sample t-test. The mean of the score in pretest is 5.71 and post-test is 8.71. After the intervention there was a little increase in the mean test score of the student. On examining the mean values, misconceptions of concept students have in the pretest are somehow cleared after the intervention.

The table below shows the comparison of the results for the experimental group.

Table 3. Paired sample test for experimental group

	Mean	N	Std. Dev.	t	p
pretest	5.47	21	1.83	-18.88	.000
posttest	15.85	21	1.38		

The paired sample t-test of the pretest and post-test scores were used to compare the correlation between the test scores. The pretest means score has increased drastically from 5.47 to 15.85 after the intervention. When the means are examined, there is a significant difference *(p<0.05)* between pretest and post-test scores. So, misconception students have in post-test are fewer than misconceptions they have in the pre-test.

The table below shows the comparison of the results between the control group and the experimental group.

The scores from the experimental and the control group were compared using independent samples t-test. There is no significant difference between the pretest scores of the experimental group and the control group regarding their answers with misconceptions *(p>0.05)*. When the means of the post-test were examined it is observed that the experimental groups' mean scores are higher than the control group So, the experimental group students' answers with misconceptions are fewer than those of the control group students with the significant difference *(p<0.05)*.

4.4 Qualitative Data Analysis

In addition to pretest and post-test, the teachers and students were interviewed to further support the findings. All interviews are recorded and each interview lasted for about 15-20 minutes. These data were analyzed by using thematic and content analysis in qualitative data analysis method. The interview was to understand the sources of misconceptions, prevailing practice of addressing misconceptions, group work practice in the schools and effect of group work in learning physics.

4.5 Sources of Misconceptions

From the response of T1, T2, T3, T4 and T5, the sources of misconceptions in physics were because of the language barriers, typing errors of the textbook, learner's preconceptions and inadequate teaching-learning materials. Learners could not understand the technical terms used by teachers. There are errors in the textbook where learners misunderstand the concepts. The materials reflected in the textbooks are not available or outdated one and do not function properly compromising the accuracy of the results. There is the believe in learners that science subjects are tough and meant for only bright learners. Below are the responses of teacher participants about misconception in science.

"It is also to deal with the understanding specially word because specially students they have poor understanding of each words, they do not understand the meaning." (T1)

"We lack the equipment, the materials mentioned in the textbooks and because of the lack of materials, most of the teachers are not able to carry out the activities mentioned in the book." (T2)

4.6 Prevailing Practice of Addressing Misconceptions

Despite facing difficulties in teaching the technical concepts in physics, teachers are trying not to dilute the meaning as far as they could. The teachers teach the concept through many ways to minimize the misconception while teaching. Science teachers simplify the language of the subject, stress more on the team and peer learning, scaffolding the weaker ones, improvise the materials and make use of technologies. The quotes below are the responses shared by teachers.

"For instance, let me take an example of sound, what I do is basically I make sound myself or sometimes I just bang the door and ask the students what I did". (T3)

"When students fail to understand the concept, I usually show them some tutorial videos related to the topic and use to simplify the task." (T5)

Table 4. Independent sample test

Student Code		N	Mean	Std. Dev.	t	p
Pretest	control	21	5.71	1.41	.47	.641
	experimental	21	5.48	1.83		
Posttest	control	21	8.71	1.64	-15.19	.000
	experimental	21	15.86	1.38		

4.7 Group Work Practiced in School

The group work used by the teachers was more of general without much proper guidance. After the nationwide training on transformative pedagogy, teachers used the guided group works in which proper monitoring and follow up of the activity is carried out. Unlike the past, guided group work involves every member to participate and learn from each other. The group works commonly practiced by science teachers in the schools are Number Heads Together, Rally Robin and Round Robin.

4.8 Effect of Group Work in Teaching and Learning Science

Group work is a cooperative learning method. According to Johnson & Johnson [50], group work promotes interpersonal skills and accountability in learning by achieving group goals. Below quotes illustrated the feelings of teachers regarding the effects of group works.

"It has huge advantage because they have enough time to share what they know and become aware of the individual talents because different students come from different family backgrounds, different intellectual backgrounds, different emotional backgrounds." (T1)

"Learners support weaker students in the group and then indirectly somehow those weaker members of the group become engaged. Even if they do not understand the concept fully, they can still catch up some concepts." (T2)

"Leaners get equal opportunities in communicating and studying." (T3)

"Every one of them get chance to express their view. They also get chances to listen to others and the other thing is that learning by doing because we understand better by doing things practically not just by listening to others." (T4)

"Learners gain the confidence and also improve speaking skills." (T5)

In this study, after intervention and interviewing 10 participants, it is found that RoundRobin is more impactful in addressing the misconception light. RoundRobin is a group work strategy where the class is divided into small groups of four or five students per group. A question is posed by the teacher and students are given time to think about the answers. Then they discuss in pair (shoulder partner or face partner) and then in a group for the common answer. At last, they shared to the whole class. Some of the responses were;

"In the Round Robin what happen in a group is, let's say if you have five members in a group, all the five members are equally participating in the group." (T2)

"Every child gets chance to express their views, then listen to the other's views and then evaluate, they know which one is right and then they come to the concession to the particular right answer that is more interesting part of them, and interesting thing in the group work." (T4)

"Mostly I use Round Robin because I found it is more appropriate for the learners." (T5)

"I prefer RoundRobin because all the members get chance to share the ideas and information and it also develop our speaking skills and communications skills." (S4)

"I prefer RoundRobin in learning physics mostly because in that group work, think time is provided and there is an opportunity given for us to exchange the idea." (S5)

5. DISCUSSION

This study attempts to find the effectiveness of group work activity and traditional method in addressing the misconception of light based on the data obtained from the test and the semi-structured interview. There was a teaching intervention and researcher also observed the classes of two different groups (experimental and control group). The study rejects the null hypothesis "Group work will not have any impact in addressing the misconceptions of light". The results from the tests confirms that the students who worked in groups while learning physics helps to address the misconception of light topic at Class IX level. During the teaching interventions, researcher observed that conceptual learning takes place through interactive teaching (group work) than conventional way of teaching where teacher controls the whole session.

5.1 Misconceptions of Light

The prevalence of misconceptions related to optics has been documented by the consistency findings over the last so many years

[30,9,10,31,6,32]. The pilot test was carried to find out the possible misconception in optics in Class X students. The detailed analysis of the test confirmed the following nine misconceptions in students. The misconceptions are:

i. Speed and angle of incident do not affect the bending of light.
ii. Ray of light is not always refracted in definite direction.
iii. The refracted ray does not bend away from the normal as it travels from denser to rarer medium.
iv. Lateral displacement does not depend on thickness of the medium, angle of refraction and angle of incidence.
v. The colour of the light, material of the medium and temperature do not affect refractive index.
vi. If the angle of the incidence of the light while leaving the denser medium is zero, the light refracts.
vii. If the angle of incidence is greater than the critical angle, the total internal reflection of the light is not possible.
viii. Twinkling of star is due to total internal reflection of light.
ix. Total internal reflection won't occur if the angle of refraction is 99 degrees (greater than critical angle).

The content analysis of the qualitative data revealed the possible factors that could have contributed towards the misconceptions of light. These are due to the abstract nature of concepts, language of instruction, lack of practical experiments, background of the students, lack of learning materials, and preconceptions about the concepts. The students are unable to clearly understand the concept when teacher uses the words that has different connotations. For example, terms like speed and velocity, deviation and bending. Misconceptions arises from prior learning either inside the classrooms or from their interaction with physical world [48].

The sample answer sheets are chosen to discuss each misconception after the intervention.

5.1.1 Misconception 1: Speed and angle of the incidence do not affect the bending of light

The correct answer of this question is the bending of light depends on change in speed and angle of the incident ray. When the light travels from denser medium to rarer medium, it bends towards the normal and hence there is more bending and vice versa. This indicates that the speed of light decreases or increases depending on the medium in which it travels. The majority (75%) of the experimental and control group were unable to answer the question correctly in the pre-test. The group work activity was carried out in experimental group while normal teaching method is used in control group to discuss on the concept of speed and angle of incidence on the bending of light. In the group activity (RoundRobin), the students discussed on the provided questions in the small group, presented to the class and further discussed with a whole class. In the process of doing group activity, students might have exchanged the different ideas and finally resolved to the scientifically correct solutions.

For the control group, students answered those questions individually. The post-test was carried out to evaluate the effectiveness of group work in addressing the misconceptions on light. The result showed that the 95% of the experimental group are able to answer correctly compared to 45% of the control group of students. There were differences among the two groups in answering the questions as well. In the post-test of the experimental group, students were also able to write some explanations but students of control group failed to explain the answers.

Although the group work intervention helped to certain extend in removing the misconceptions, still the concept that the angle of incidence effecting the bending is not yet totally addressed as reflected in the answer sheets. The topic can be taught through simulations to address the misconception far better than group work.

5.1.2 Misconception 2. Ray of light is not always refracted in a definite direction

The correct answer is that the ray of light is always refracted in a definite direction. The direction of refraction depends on the speed of the light ray. As the speed of light changes, the direction also changes. So, depending on the speed and angle of incident, the refracted ray will always have a definite direction. Since this concept falls under the same topic, the conceptual teaching and group activity used were same. In the pre-test 90% of experimental

group and 70% of the control group failed to answer correctly. After the intervention, 90% of the experimental group were able to answer correctly while the result of the control group remained the same as that of pre-test.

The maximum number of students 90%) answered it correctly after the group work intervention. The students learned that the direction of refracted ray is controlled by the direction of incidence ray but they could not explain with regard to speed and direction. This may be due to inadequate understanding of Snell's law and its applcation. This indicated that the misconception was not fully removed after the intervention and requires lots of practices in solving problem related to the direction using Snell's law.

5.1.3 Misconception 3. The refracted ray does not bend away from the normal as it travels from denser to rarer medium

The correct answer is refracted ray bend away from the normal when the ray of light travel from denser to the rarer medium. That is, when the light ray travels from water to air, the refracted ray bends away from the normal. The group work intervention (Think-Write-Share) is used in experimental group and traditional teaching was done for the control group. The pre-test result showed that 45% of the experimental and 61% of the control group answered correctly. After the intervention, there is large improvement in the test score for the experimental group and control group. This is shown in the post-test result in which 95% of the experimental group and 90% of the control group could answer the questions correctly. In doing the group work (Think-Write-Share), students might have done the informal debates while sharing among the group members as well as with the whole class. In a way, the alternate conceptions might have filtered and the students learned the correct concepts.

In the post-test sample answer, the student ticked the correct answer and also support the answer with scientific understanding of the refractive index. It is evident from the sample answer where student clearly wrote that water is denser than air therefore refracted ray bends away from the normal. The intervention has helped to understand the concept of the refraction.

5.1.4 Misconception 4. Lateral displacement does not depend on the thickness of the medium, angle of refraction and angle of incidence

The correct answer is that the lateral displacement depends on the thickness of the medium, angle of incidence and angle of refraction. The lateral displacement is the perpendicular distance between the path of emergent ray and the direction of the incident ray. The thicker the glass slab, more is lateral displacement. The lateral shift also increases with increase in angle of incidence. For the angle of refraction, it is just opposite that is when the angle of refraction decreases, the lateral shift increases. As an intervention, group work activity (carousal brainstorming) was used while teaching the concept and conducting the activity. In the pre-test result, 5% of experimental group and 10% of control group answered the question correctly. However, after the intervention, a slight improvement was seen in the answer as 60% of experimental group and 25% of control group answered correctly. The reason of percentage differences between the experimental group and the control group is because of the group work intervention. In learning through carousal brainstorming, students might have gathered more ideas and collaboratively justified the solution to the most correct one.

Although students couldnot express the clear reason on why lateral displacement depends on the given three factors, student has somehow chose the correct answer after the intervention. In the post-test of the control group, students have written nothing to explain the answer but for the experimental group, students wrote something which tells that there was some learning through intervention. From the analysis of the group activity and the students answer sheet, the misconception would have been addressed if drawing of ray diagram was provided in the activity.

5.1.5 Misconception 5. The colour of the light, the material of the medium and temperature do not affect refractive index

The correct answer is that the refractive index of the medium depends upon the colour of the light, the material of the medium and temperature. The refractive index of the medium decreases with increase in the wavelength of the light. That is for the violet colour, refractive index of a medium for

violet is more compared to red colour. The denser the material, the more is the refractive index. It is also found that refractive index increases with decrease in temperature. In the intervention, there was concept teaching through white board and then group work activity(Think-Write-Share). The students were asked to go through the textbook and brainstorm on how each factor affect the refractive index. In the pre-test, 95% of the experimental group and all the control failed to answer correctly but after the intervention and post-test, percentage of experimental group and control group who could not answer it properly reduced to 30% and 55%.

Although most of the student couldnot write the reason on why those factors affect the refractive index after the intervention, they answered correctly. From the given answers, one cannot claim that their misconceptions was cleared but the correct answer indicate some improvement in understanding the concept. The topic can be taught by incorporating video lesson to address the misconception more clearly.

5.1.6 Misconception 6. If the angle of the incidence of the light while leaving the denser medium is zero, the light refracts

The correct answer is when the angle of the incidence of the light while leaving the denser medium is zero, then light travel straight without any refraction. Although there is no bending of the refracted ray at the zero-degree angle of incidence, still there will be change in speed but not the direction. Before the intervention, majority (75%) of the experimental group and control group (60%) could not answer it but after the intervention only 15% of the experimental group failed to answer correctly. In contrast to experimental group, still 55% of the control group could not answer it even after the teaching intervention.

After the intervention, the students not only answered the question correctly but also could provide correct explanation. This suggest that group work intervention was effective in understanding the concept better.

5.1.7 Misconception 7. If the angle of incidence is greater than the critical angle, the total internal reflection of the light is not possible

The correct answer is the total internal reflection occurs when the angle of the incidence in the denser medium is greater than the critical angle. The critical angle is angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°. As the angle of incidence exceeds the critical angle, the ray is totally reflected back in the same medium. To teach the concept, there was conceptual teaching using boards and then group activity (RoundRobin) was carried out. The group task was to discuss on the factors that affects the total internal reflection. In the pre-test 15% of the experimental group and 45% of the control group could answer it correctly. After the intervention, 85% of the experimental group answered correctly. However, for the control group, 70% of the students could not answer it correctly. Some sample answers of experimental group(post-test) is given below.

In the post test answers, beside ticking the correct answer, the supporting reason showed the student's understanding of the total internal reflection had improved to certain extend. They are able to point out that light travels from denser medium to rarer medium.

5.1.8 Misconception 8. The twinkling of the star is due to total internal reflection of light

The correct answer is that the twinkling of star is not due to the phenomena of total internal reflection. The star twinkles because of the commotion in the atmosphere of the earth. As the atmosphere moves to and fro, the light from the star get refracted in multiple directions. That makes the star's image change slightly in brightness and position. Hence to the observer, it seems like star twinkles. The Round Robin was used as a group activity in teaching the natural phenomena of the total internal reflection such as mirage, looming and sparkling of diamond. Before the intervention, 25% of the experimental group and 30% of the control group answered correctly. In the post-test, 65% of the experimental group could answered it correctly. For the control group, instead of decreasing, the percentage of student who could not answered increased to 80%.

5.1.9 Misconception 9. Total internal reflection won't occur if the angle of refraction in the rarer medium is 99°

The correct answer is that the total internal reflection takes place when the angle of the refraction in the rarer medium exceeds $90°$. In the intervention teaching, concept of total internal

relection is taught and then RoundRobin is used as group work activity to brainstorm the given questions. All the students from both the groups initially failed to answer it correctly. However after the intervention teaching, 60% of the experimental group and 15% of the control group could answer correctly.

5.2 Strategies used by Teachers Towards Conceptual Learning and Addressing Misconceptions

The study carried out by [19] suggest that conceptual teaching be given more importance to remove students' misconceptions in understanding science topics. Many strategies are used by educators to address misconceptions. These are conceptual change model, constructivist theory, teaching through experiments, hands on activities, problem solving method, enquiry teaching method and project based learning. In this study, group work strategy and lecture cum demonstration is used during intervention studies for different groups to address the misconception.

According to the result obtained at the end of the teaching intervention, there was a decrease in the misconceptions of light with the group work strategy. The teacher interviewee shared that learning through media like Youtube can also minimize the misconceptions. It is because in the videos, it provides the students with visual and aural stimulation of the concept explained thus helping to develop deeper understanding of the concept. Another participant pointed out that simplification of terms and teaching through real life connection help connects the concept with real situations. Consequently, the students are able to retain the information for longer duration and thus help to address some misconceptions on the topic.

5.3 T-tests Interpretation of the Post-Tests

The comparison of pre-test and post-test results within the groups and among the two groups were done by comparing mean, standard deviation and significant value. The standard deviation of means of post-tests in the control group and the experimental group were 1.64 and 1.38 respectively as shown in the Table 4. There was intervention teaching using traditional method in the control group and teaching through group work activity in the experimental group. The standard deviation of the post-test of the control group had increased by 0.23 comparing to pre-test. This indicated that the scores of the students were widely scattered which means students in the control group had more variation in the learning ability. It suggests that the traditional teaching helped only few students in understanding the concept. The standard deviation of the post-test of the experimental group had decreased by 0.43 when compared to pre-test. This indicated that the scores of the students were more concentrated, meaning there was not much variation in the learning ability. This suggests that the teaching through group work activity helped every student to understand the concept taught in the class.

In the pre-test, there were no significant mean difference between the control group and the experimental group but in the post-test, the mean difference between the control group and the experimental group was 7.15 with significant value $p<0.05$. This showed that the test scores in the post-test for the experimental group was significantly higher than the test scores of control group in the post-test. The probable value less than the standard value confirmed that the mean difference is due to the intervention with group work. Therefore, this finding rejects the null hypothesis that states, group work will not have any impact in addressing the misconceptions of light. Rather, it accepts an alternative hypothesis that states, group work will have impact on addressing the misconceptions of light at Class IX.

5.4 Impacts of Group Work

Students taught in small groups achieve higher grades, are more motivated to use a deep approach to learning, retain information longer and acquire greater teamwork and communication skills than students taught in a traditional method [52]. In the experimental group, five different structured group works such as RoundRobin, Think-Write-Share, RoundTable, RallyTable, and Carousal Brainstorming are used to teach light concepts. The post-test result reveals that there is decrease in all the nine identified misconceptions of light in comparison to the pre-tests. The possible reason can be because of active participation of the students in the learning process. For the control group, the traditional teaching method especially lecture cum demonstration was used in teaching the same topic. Most of the students were passive learners, and only few participated in the discussion.

The post-test reveals that only six misconceptions (Misconception 1,3,4,5,6 and 9) were reduced despite of teaching intervention in the control group. Perhaps, student understood the concept quite well through lecture cum demonstration teaching strategy for those six misconceptions. There was no change for one misconception (Misconception 2) even after the teaching. To the surprise, instead of addressing the misconceptions, the learners were further added with more misconceptions for the two identified misconceptions (Misconception 7 and 8). These result suggests that traditional way of teaching is not that effective in addressing the misconceptions. This is confirmed in the study by [37], that the traditional teaching method based instruction was found to be ineffective for learners to gain a concrete understanding of science concept. Hence, there is a high chance that students developing misconception over the years.

In the experimental group, all the misconceptions were partly addressed by the group work intervention. The group work used as an intervention are, Round Robin, Round Table, Carousal Brainstorming, Think-Write-Share, and Rally Table. In the Round Robin, question is provided, given the think time, student share their answers among the group and finally agree with the most correct answer. In the Round Table, question is provided or either topic is provided for the discussion, students are provided with think time, student write their answer or opinion in the chart paper and at the end student come to the common answer which is valid and scientifically correct. In Carousal Brainstorming, the process is similar to Round Table where group member write individually and share with other members. Then in the group, organize the answer and share to the class. In Think-Write-Share, student think first, then student write it in a paper or notebook, then share with the other members. It can be done in pair as well as in group. In Rally Table, the process is same as Think-Pair-Share, where student think, then paired up among the group and exchange the answers. So, in general, in all the structured group work, the common thing is first student work individually, then with small group and finally with the class. When the learning takes place through group work activity, student become aware of their existing knowledge, students are able to explore more knowledge through other's answers and able to judge the most accurate and scientific understanding of the topic.

The result obtained from the post-test is analyzed and seen that the students in the experimental group are more successful than the control group. The reason is that the students in the experimental group, studied the topics related to misconceptions through active participation creating the successful discussion environment. The finding agrees with many studies [40,53,54,55,56], that presented about the learning advantages of group work. Jean Piaget [57] found that through cognitive conflicts, students modify their own concepts and adopt new ones presented in the environments. The findings also show that the results of the learning through group works are far better than the students who learn individually. It is aligned with the theory of assimilation and accommodation in learning [58]. According to Zhiqing [58], assimilation is the process by which a subject combine with a perceived stimulus into the existing schema. The subject then adjusts the old schema or build a new schema on the basis of the old one in order to accept and accommodate the new object. This process is called accommodation in learning. In the group work, student with learning difficulties can assimilate the concepts shared by brighter member and accommodate accordingly. The students in the group activity remember the information better and perform academic result better than students who worked individually.

The study found out that group work has positive impact in addressing the misconceptions of light comparing to the traditional way of teaching. Thus it disagrees with a number of other studies that were resistance to the use of group-work [59,60,61,62]. Some of the negative impacts of the group work as mentioned in those articles were, it interrupts the flow of the lesson, slow down the coverage of the curriculum, it involves the loss of classroom control, increased noise, disruption and off task behaviour, beliefs that children did not work together and are unable to learn from one another. However, in the study there was no such incidences occurred. It might be the case when the group work activity is not structured and organized. When there is careful facilitation, proper directions, instructions and attentions are provided to the group work, it prevents from group work issues. Rather the study observed that group work supports the students to develop the varieties of learning strategies such as team-based learning, problem-based learning, collaborative learning, cooperative learning, team learning, inter-professional learning and active learning. The

group work intervention had positive impact in addressing the misconception of light in this study.

5.5 Class Observations

This study involved teaching and observation in both experimental and control group of the student. There was a wide ranges of differences in learning between the two groups. In the experimental group, every learner was found actively participating in the group activities. Every member was involved doing something; sharing their points, writing on the charts, doing presentation, helps in defending their work and refining their works after the feedbacks. Chiriac [63] also confirmed similar student involvement and option for sharing in group to enhance academic. On the other hand, in the control group, all the learners were not involved in discussion except for few who are good in academics and are bold enough to face or learners. Most of the learners remain as passive listener when teaching is focused to lecture strategy. Through the observations and use of group work strategy, conclusions can be drawn that more conceptual learning takes place through group work activities than traditional lecture methods.

5.6 Perceptions towards Group Work

Different educationist has their own perceptions towards the use of group work activities in learning. Owing to the convenience and limited time, science teachers use those mentioned group works because these are easier to manage and it consume less time. One of the teacher mentioned that usage of group works also depends on the topic of the subject. This suggest that the group work activity which works well with one topic may not work in another topic.

Teacher interviewee (T3) expressed that in terms of percentage wise, about 70-80 percent, group work activities benefits the teaching and learning. It also suggests that proper planning is required in implementing the group work activities. Despite of minimal group work related issues, teachers still emphasize on the use of group work in teaching. It is because there are wide ranges of advantages than disadvantages. Another teacher interviewee (T2) expressed that group work prompts every learner to participate and make responsible in learning unlike traditional method of teaching and learning. Even the student participants (S4, S5), shared that they develop skills such as listening and communication skills thereby helping to build self confidence in learning the subjects. There were ten interviewees and out of ten, eight of them prefer RoundRobin in teaching and learning science. RoundRobin is a structured group work framed by Kagan after so many research works in that field of cooperative learning. It consists of three steps; teacher pose the question, students think for some time, every member has to share to the group and finally come to the consensus to the most correct solution. It is structured because it has proper step to follow and takes merely around 4-5 minutes (Kagan, 2003). Generally, teachers and students have positive perspective about the group works in the field of teaching and learning.

6. CONCLUSION

Physics is a dynamic subject that guides the everyday activities. Over the years, researchers found that there are misconceptions in the physics concepts. The purpose of the study was to investigate the effect of group work in addressing the misconception of light in Class IX. It was also to explore the effect of group work over the traditional method in teaching and learning the physics concepts. For the study, explanatory sequential mixed method is used. It is a type of mixed method where quantitative method is followed by qualitative method. There was pre-test followed by an intervention teaching and post-test at the end. The random sampling was used for the study. The participants were divided into two groups; experimental group and control group. For each group, intervention teaching was carried out but with different methods. In the experimental group, teaching was extensively focused on the group work strategies and traditional way of teaching for the control group. At the end of the intervention teaching, there was post-test conducted to investigate the impact of group work over traditional method in addressing the misconception of light concept. There was semi-structured interview that further supports the quantitative data and informal class observations.

The result obtained from the study rejects the null hypothesis. The findings confirm that the group work is effective in addressing the misconceptions of light comparing to traditional method of teaching and learning. An active learning strategy where student's participation is

maximum helps for students to conceptualize the lesson better than lecture centered teaching approach. From the data obtained, it is concluded that the group works that are structured and required less time are more applicable in the physics class. The study also found out that there are misconceptions in the light concepts and traditional teaching is not that effective in addressing the misconceptions. Although the misconceptions help to conceptualize the concepts, it needs more focus on the cause and way to address it. In the study, extensive group work is used as an intervention to address the misconceptions of the light. In the group work, students not only learn from others but argue their opinion to make it more scientifically valid. From the data, it was concluded that probable sources of misconceptions are due to the language used by the teachers, textbook errors and incomplete information in the textbooks, and learner's preconceived ideas. In the schools, teachers used different strategies for an effort to address misconceptions by using simulations, conducting experiments, providing more reading materials and simplifying the terms they teach. The study concluded that group work teaching also helps in reducing the misconceptions in the physics.

This study suggests the teachers to use the group work while teaching because it is one of the active learning strategy. In the group work, students learn from each other by sharing the individual thoughts, making an informal debate as they discuss and finally drawing the most probable solutions to the questions. The group work makes an individual students equally accountable and responsible in learning. This study would benefit the teachers in teaching the light concepts with minimal misconceptions and help them to explore more on the basis of the study. It would also help students in learning the concepts more scientifically without much misconceptions.

7. IMPLICATIONS

The study instill the fact that as simple as group work can also address misconception and learn that group work plays an important role in learning the concepts. It reminds the teachers not to depend fully to the traditional way of teaching because conceptual learning demands active learning strategies such as group works. Group works does not only enhance the academic performance but also helps to develop skills such as socialization skill, communication skill, listening skill, problem solving skill and other life skills.

8. LIMITATIONS

The study has some limitations. This type of study by its nature, requires more time particularly in collecting data. It requires proper planning for the intervention and at the same time flexibility because participants need to involve time and again. The participants must involve with genuine willingness and must be aware of study. This study owing to a particular school and less sampling may not contribute to generalization to the larger extend.

9. RECOMMENDATIONS

From the findings of this study, the following recommendations are offered:

1. If anybody wants to apply this method, it is recommended to spend enough time in planning, use some more tools for data collection, and prioritize to conceptual teaching while doing group work activities. It is also recommended to try this method with other topics of physics and other subjects as well.
2. The study recommends the teachers to be aware of the misconceptions of students in order to provide effective and scientific based teaching. It is also suggested that teacher incorporate different strategies in the group work teaching so that students broaden the way of learning.

CONSENT AND ETHICAL APPROVAL

As per university standard guideline, participant consent and ethical approval have been collected and preserved by the authors

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Velo ARN. Attitude towards physics and additional mathematics achievement. International Education Studies. 2015;35-43.
2. Stein M. A study of common beliefs and misconceptions in physical science. Journal of Elementary Science Education. 2008;20(2):1-11.
3. Canada FC, DGGR. Change in elementary school students' misconceptions on material systems after a theoretical-practical instruction. International Electronic Journal of Elementary Education. 2017;499-510.
4. Anthony G. Whither ability grouping: Changing the object of groupwork. Opening up Mathematics Education Research. 2016;117-125.
5. Mutch A. Employability or learning? Groupwork in higher education. Education + Training. 1998;50-56.
6. Shallcross R. Seeing the light. Common Misconception. 2017;5-7.
7. Djanette B. Detemination of university students' misconception about ight using concept map. Social and Behavioral Science. 2014;582-589.
8. Favale F. Misconceptions about optics: An effect of misleading explanations. ETOP. 2013;1-5.
9. Hadzibegovic Z, Slisko J. Changing university students' alternative conceptions of optics by active learning. C.E.P.S Journal. 2013;3:29-48.
10. Keles E. A study towards correcting student misconceptions related to the color issue in light unit with POE technique. Social and Behavioral Science. 2010;3134-3139.
11. Adair AM. Students' misconceptions about Newtonian mechanics: Origins and solutions through changes in instruction. ProQuest Dissertations and Thesis; Thesis (Ph.D.)-- The Ohio State University, Columbus, USA; 2013.
12. Celik H. An examination of cross sectional change in student's metaphorical perceptions towards heat, temperature and energy concepts. International Journal of Education in Mathematics, Science and Technology. 2016;4(3):229-245.
13. Kapici HO. Particulate nature of matter misconceptions held by middle and high school students in Turkey. European Journal of Education Studies. 2016;2(8), 43-58.
14. Widiyatmoko A. Literature review of factors contributing to students' misconceptions in light andoptical optical instruments. International Journal of Environmental & Science Education. 2018;13(10):853-863.
15. Saleh S. Malaysian students' motivation towards physics learning. European Journal of Science and Mathematics Education. 2014;2(4):223-232.
16. Holubova R. Physics and everyday life: New modules to motivate students. US-China Education Review. 2013;114-118.
17. Baser M. Effect of conceptual change oriented instruction on students' understanding of heat and temperature concepts. Journal of Maltese Education Research. 2006;4(1):64-79.
18. Mekonnen S. Problems challenging the academic performance of physics students in higher governmental institutions in the case of arbaminch, Wolayita Sodo, Hawassa and Dilla Universities. Natural Science. 2014;362-375.
19. Ergin S. The effect of group work on misconceptions on 9th Grade students about Newtons laws. Journal of Education and Training Studies. 2016;4(6):127-136.
20. Gilbert JK, Watts. Concepts, misconceptions and alternative conceptions: Changing perspectives in science education. Studies in Science Education. 1983;61-98.
21. Lane, R. Students' alternative conceptions in geography. Geographical Education. 2008;43-52.
22. Olusola OO. Attitudes of students towards the study of physics in college of education. American International Journal of Contemporary Research. 2012;2(12), 86-89.
23. Demirci N. A study about student's misconceptions in force and motion. The Turkish Online Journal of Educational Technology. 2005;4(3):40-48.
24. Dole JA, Sinatra GM. Reconceptualising change in the cognitive construction of

knowledge. Educational Psychologist. 1998;33:109-128.
25. Duit R. Conceptual change approaches in science education. New Perspectives on Conceptual Change. 1999;263-282.
26. Piaget J. The language and thought of the child. Routledge 11 New Fatter Lane, London, New York; 2001.
27. Stepans J. Targeting students' science misconceptions. Showboard, Inc; 2006.
28. Garbett D. Constructivism deconstructed in science teacher education. Australian Journal of Teacher Education. 2011;36-49.
29. Blizak D. Students misconception about light in Algeria. ETOP. 2009;1-8.
30. Chantaranima T. Grade 11 student's existing ideas about natures of light. Social and Behavioral Science. 2014;693-697.
31. Schutzenhofer CH. Students' conceptions on white light and implications for teaching and learning about colour. Physics Education. 2017;52:1-8.
32. Uzun S. A cross-age study of an understanding of light and sight concepts in physics. Science Education International. 2013;24(2):129-149.
33. Ling TW. Fostering understanding and reducing misconceptions about image formation by a plane mirror using oncstructivist-based hands-on cctivities. Springer Singapore. 2017;203-223.
34. Oberoi M. Review of literature on students' misconception in science. International Journal of Scientific Research and Education. 2017;5(3):6274-6280.
35. Sesen BA. Internet as a source of misconception. The Turkish Online Journal of Educational Technology. 2010;94-100.
36. Boller BR. Non-traditional teaching styles in physics. EDRS, 1999;120:1-18.
37. Quan Gina. Improvements of students' understanding of heat andtemperature. 2011;1-16.
38. Chin Christine. Students' questions and discursive interactions: How they impact argumentation during collaborative group discussions in science. Contemporary Science Education Research. 2010;1-12.
39. Burke A. Group work: How to se groups effectively. The Journal of Effective Teaching. 2011;87-95.
40. Alfares N. Benefits and difficulties of learning in group work in EFL classes in Saudi Arabia. English Language Teaching. 2017;10(7):247-257.
41. Sofroniou A, Poutos K. Investigating the effectiveness of groupwork. Educational Science. 2016;1-15.
42. Harris G, Bristow D. The role of group regulation in student groups: A pedagogical exploration. e-Journal of Business Education and Scholarship of Teaching, 2016;10(2):47-59.
43. Slavin RE. Cooperative learning. Review of Educational Research. 2010;315-342.
44. Wang Z. Effects of heterogenous and homogeneous grouping on student's learning. 2013;1-56.
45. Teaching skills (1st ed.). Paro: National Institute of Education, Paro; 2003.
46. Kagan S. A brief history of Kagan structures. Kagan Online Magazine, 2003; 4-23.
47. Maqbool J. Group work and the impact, if any, of the use of google applications for education. 13th International Conference on Cognition and Exploratory Learning in Digital Age. 2016;149-156.
48. Goris T, Dyrenfurth M. Students' misconceptions in science, technology and engineering. ResearchGate, 2014;1-16.
49. Aksoy G, Gurbuz F. Group investigation teaching technique in Turkish primary science courses. Balkan Physics Letters. 2013;99-106.
50. Johnson RT, Johnson DW. Cooperative learning in the science classroom. Physical Science Magazine. 2013;19-20.
51. Harlow JB, Meyertholen D. Effective student teams for collaborative learning in an introductory university physics course. Physical Review Physics Education Research. 2016;12:01-11.
52. Borg M, Kembro J, Notander JP, Petersson C, Ohlsson L. Conflict management in student groups-a teacher's perspective in higher education. Hogre Utbildning. 2011;1(2):111-124.
53. Hodges LC. Ten research-based steps for effective group work. IDEA Paper. 2017;65:1-11.
54. Milicevic D, Pecic L. Cooperative learning in teaching physics and art in secondary schools. Series: Physics, Chemistry and Technology. 2016;14(1):61-78.
55. Taqi HA, Al-Nouh NA. Effect of group work on EFL students' attitudes and learning higher education. Journal of Education and Learning. 2014;3(2):52-65.

56. Tarhan L, Sesen B. Jigsaw cooperative learning. Chem. Educ. Res. Pract., 2012; 13:307-313.
57. Khurram MF. Cognitive development in Jean Piaget's work and its implications for teachers. World Applied Sciences Journal. 2011;1260-1265.
58. Zhiqing Z. Assimilation, accommodation, and equilibration. International Forum of Teaching and Studies. 2015;84-89.
59. Baines E. The challenges of implementing group-work in primary school classrooms including pupils with Special Educational Needs. Special Issue of Education. 2015; 1-18.
60. Linneman JA. Share, show and tell: Group discussion or simulation versus lecture teaching strategies in a research method course. American Sociological Association. 2018;47(1):22-31.
61. Moraes C, Michailidou N. Students' attitude toward a group coursework protocol and peer assessment system. Open Research Online. 2016;30(2):117-128.
62. Roberts TS. Seven problems of online group learning. Educatonal Technology and Society. 2007;257-268.
63. Chiriac EH. Group work as an incentive for learning. Frontiers in Psychology. 2014;1-10.

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